



Fighting Gravity – A matter of balance

DESCRIPTION

This lesson guide integrates a series of activities highlighting what must be done to overcome effects of gravity for Earth orbit.

OBJECTIVES

Students will:

- Locate the center of gravity of an object
- Experiment with designs for a heavy lift vehicle

NASA SUMMER OF INNOVATION

UNIT

Physical Science – Gravity

GRADE LEVELS

4th – 6th

CONNECTION TO CURRICULUM

science, mathematics, technology

TEACHER PREPARATION TIME

1 hour

LESSON TIME NEEDED

2 hours Complexity: Basic

NATIONAL STANDARDS

National Science Education Standards (NSTA)

Science as Inquiry

- Skills necessary to become independent inquirers about the natural world

Physical Science

- Motions and Forces
- Transfer of Energy

Science in Personal and Social Perspectives

- Science and technology in society

MANAGEMENT

Groups of 3-4 students are recommended for both activities. For the Heavy Lifting activity, it is best to put the fishing line through the straw before attaching it to the ceiling.

CONTENT RESEARCH

The force of gravity permeates all aspects of life as we know it including social and recreational interactions. The pull of gravity depends on the amount of mass and the distance between centers of mass of objects. Forces applied to lift an object must be applied through the center of gravity of an object to avoid rotation.

Key Terms

- **Gravity** – the attractive force between any two massive objects
- **Center of Mass** – the point where all mass of an object is concentrated.
- **Center of Gravity** – the point on an object where the force of gravity is concentrated
- **Balance** – condition where forces equally oppose one another

Misconceptions – Students will often place the center of mass and center of gravity of an object in the same location. This is only true if the object is in a uniform gravitational field. Students also often believe that once in orbit, gravity has no effect. Orbit exists because gravity constantly changes the direction of an object which is moving at right angles to the pull of gravity.

LESSON ACTIVITIES

The suggested sequence starts by introducing students to the concept of balance and then applies it to rocket launches.

Fluttering Fun, Point of Balance

Students study balance using an irregular shape and paperclips.

http://scifiles.larc.nasa.gov/docs/guides/guide4_00.pdf

Heavy Lifting

Students configure balloons to carry a load of paperclips to the ceiling.

http://www.nasa.gov/pdf/153418main_Rockets_Heavy_Lifting.pdf

RELATED RESOURCES

Web activity simulating Newton's cannonball thought experiment for the first artificial satellite

<http://spaceplace.nasa.gov/en/kids/orbits1.shtml>

Webpage showing center of gravity calculations and another method of determining center of gravity

<http://www.grc.nasa.gov/WWW/K-12/airplane/cg.html>

Activity finding center of gravity using plumb lines

http://www.nasa.gov/pdf/382714main_ETE_Lesson_2.pdf

DISCUSSION QUESTIONS

Each activity includes questions for discussion.

Additional questions:

- Why would NASA scientists need to know the center of gravity of a rocket? *If thrust is not applied through the center of gravity, the rocket will tumble end over end*
- Why do we make rockets round? *It makes them more stable*

ASSESSMENT ACTIVITIES

Each activity has a series of questions in the student pages.

Pretest / Posttest questions:

- What is the center of gravity? *The point at which the force of gravity is concentrated*
- Explain why shape matters when designing a rocket. *Answers will vary but should indicate the need for balance*

ENRICHMENT

- Have students find the center of gravity of their heavy lifter.
- Have students investigate the plumb line and balance methods for finding center of gravity and decide which is more accurate.

MATERIALS

- Construction paper
- Pencil with flat eraser
- Modeling clay
- Scissors
- Paperclips
- Large binder clips
- Long balloons
- Dixie cups
- Straight drinking straws
- Masking tape